GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[X] ORIGINAL [ ] REVISION NO. ______

Project No. E-21-A07 R6059-0A7 GTRC/~~GIT~~ DATE 2 /25 / 86

Project Director: Roger P. Webb School/~~Lab~~ EE

Sponsor: Georgia Power Company 333 Piedmont Avenue
P.O. Box 4545 Atlanta, Georgia 30302

Type Agreement: Letter of Acceptance Dated 1/22/86-Task EA2 (BOA #95)

Award Period: From 1/1/86 To ~~12/31/86~~ 7/30/87 (Performance) 12/31/86 (Reports)

Sponsor Amount:

	This Change	Total to Date
Estimated:	$ 82,101.00	$ 82,101.00
Funded:	$ 82,101.00	$ 82,101.00

Cost Sharing Amount: $ ______ Cost Sharing No: ______

Title: Power Electronics Laboratory Development

ADMINISTRATIVE DATA OCA Contact R. Dennis Farmer X4820

1) Sponsor Technical Contact:

2) Sponsor Admin/Contractual Matters:
Gary L. Birdwell
Georgia Power Company
333 Piedmont Avenue, N.E. (20th Floor)
Atlanta, Georgia 30308
(404) 526-6526

Defense Priority Rating: N/A Military Security Classification: UNCLASSIFIED
(or) Company/Industrial Proprietary: Non-Disclosure Agreement

RESTRICTIONS

See Attached ______ Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval – Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with Sponsor

COMMENTS:

COPIES TO: SPONSOR'S I. D. NO. 02.256.000.86.012

Project Director	Procurement/GTRI Supply Services	GTRC
Research Administrative Network	Research Security Services	Library
Research Property Management	Reports Coordinator (OCA)	Project File
Accounting	Research Communications (2)	Other Jones/Legal

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date 4/18/88

Project No. E-21-A07 School/~~Lab~~ EE

Includes Subproject No.(s) N/A

Project Director(s) Roger Webb GTRC/~~GIT~~

Sponsor Georgia Power Company

Title Power Electronics Laboratory Development

Effective Completion Date: 7/30/87 (Performance) 7/30/87 (Reports)

Grant/Contract Closeout Actions Remaining:

- [ ] None
- [x] Final Invoice or Copy of Last Invoice Serving as Final
- [ ] Release and Assignment
- [ ] Final Report of Inventions and/or Subcontract: Patent and Subcontract Questionnaire sent to Project Director [ ]
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other

Continues Project No. E-21-A06 Continued by Project No.

COPIES TO:

Project Director
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Other

GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL OF ELECTRICAL ENGINEERING
ATLANTA, GEORGIA 30332

TELEPHONE: (404) 894-

October 3, 1986 E-21-A07

Gary Birdwell
Georgia Power Company
P.O. Box 4545
Atlanta, GA 30302

Dear Gary,

Attached are activity reports for the month of August for five Georgia Power Projects under BOA-95. If you have any questions, or need further information, please call me.

Sincerely,

Roger P. Webb
Professor and Associate Director

RPW/pk
Attachments

GEORGIA POWER COMPANY GENERAL PURCHASING AGREEMENT

TECHNOLOGY DEVELOPMENT CENTER TASK STATEMENT - BOA 95 - TASK RP2 - E21-A01

PROJECT NAME: Controller for E-Tech's HVAC System

PRINCIPAL INVESTIGATOR: Gail Wells

PROGRESS REPORT FOR: August 1986

Activities for the month of August were devoted to building and testing the second prototype controller for the E-Tech HVAC system. This second prototype differs from the first in the following details:

- It is less than half the size of the first prototype.

- The input boards and output boards used on the first controller have been modified so that solid state I/O isolation modules could be tested in this application.

- Some of the 1A output relays of the first design have been replaced with relays that can switch higher currents. As a result, it will be possible to eliminate some of the relays on the HVAC system since this second prototype will be able to handle switching demands as well as control functions.

- The wiring for the thermostat inputs has been redesigned to accommodate the inputs that are actually available. These inputs were only tentatively defined at the time of the original controller design.

- This prototype will have a 230 VAC power supply rather than 120 VAC, for compatibility with the HVAC system.

The controller software, as well as the hardware, had to be changed significantly as a result of the newly defined thermostat inputs. This was necessary in order for the software to correctly interpret the input signal in determining the mode of the HVAC system.

GEORGIA POWER COMPANY GENERAL PURCHASING AGREEMENT

TECHNOLOGY DEVELOPMENT CENTER TASK STATEMENT - BOA 95 - TASK A1 - E21-A02

PROJECT NAME: Radiative Electrotechnologies and Their Applications

PRINCIPAL INVESTIGATOR: A. S. Debs and W. Sykes

PROGRESS REPORT FOR: August 1986

Effort was concentrated on the following radiative electrotechnologies:

- Microwave drying and heating
- Radio frequency drying and heating
- Infrared heating and curing
- Ultraviolet curing
- Electron beam curing.

Emphasis was placed on the following areas:

- Technical characterization of each technology
- Case studies of successful implementations in Georgia and outside
- Analysis of potential applications in Georgia with emphasis on costs and benefits.

By end of August 1986, almost all data for report preparation was collected and analyzed. Three case studies were carried out. Numerous Georgia industries were contacted regarding successful implementation of radiative electrotechnologies.

Fall Quarter activities will concentrate mainly on final report preparation, and the collection of additional information.

GEORGIA POWER COMPANY GENERAL PURCHASING AGREEMENT

TECHNOLOGY DEVELOPMENT CENTER TASK STATEMENT - BOA 95 - TASK EA1 - E21-A03

PROJECT NAME: Adjustable Speed Drives/Power Electronics

PRINCIPAL INVESTIGATOR: George Vachtsevanos

PROGRESS REPORT FOR: August 1986

Following are the highlights of our activities for the Georgia Power project concerning power electronics/ASDs:

- The project was initiated with an extensive survey of U.S. and foreign manufacturers of Adjustable Speed Drives. A directory has been compiled and several manufacturers have been contacted for product information.

- We investigated existing and potential applications of ASDs in the pulp and paper industry. A similar effort will be completed in the future for other Georgia based industries (textiles, etc.)

- An adjustable speed control (ASCON) analysis computer program, provided by EPRI, was implemented and simulation results were supplied to the pulp and paper research group.

- At the request of Georgia Power, we prepared an instrumentation requirements study for a power electronics test facility.

- We investigated new ASD control technologies. In particular, we developed appropriate models for induction motor/control devices and performed several computer simulation studies.

- We completed the conceptual design of a computer aided test facility for ASDs. The facility will be used to:

  - Determine the operational characteristics of ASDs;
  - Investigate the impact of ASDs on power quality;
  - Study the effect of power line disturbances on ASD operation;
  - Design appropriate protection schemes;
  - Train Georgia Power field personnel on the characteristics and applications of ASD devices;
  - Demonstrate to potential users the technical and economic advantages of ASDs.

GEORGIA POWER COMPANY GENERAL PURCHASING AGREEMENT

TECHNOLOGY DEVELOPMENT CENTER TASK STATEMENT - BOA 95 - TASK EP1 - E19-A05

PROJECT NAME: Technical Support on Pulp and Paper Processes

PRINCIPAL INVESTIGATOR: Jeffrey Hsieh

PROGRESS REPORT FOR: August 1986

- Completed the information gathering, drafting, editing the first "Technical Brief" entitled, "High Shear Mixer," which is widely used in the alkaline oxidative extraction stage of pulp bleaching processes.

- Requested 25 copies of High Shear Mixer technical bulletins for Georgia Power from each of the following equipment suppliers:

  - Sunds Defibrators
  - Impco Inc.
  - Kaymer.

- Assessed the potential of new solvent pulping processes appeared in Pulp and Paper Week.

- Completed the information gathering related to the new RDH (Radar Displacement Heating) system. This modified pulping system for batch digesters is designed and marketed by Beloit Corporation.

- Interacted with technical and marketing groups of Pulping Systems Division of Beloit for future joint effort in using RDH technology in the pulp mills of Georgia. The very first commercial installation of "Radar Displacement System" is located in Valdosta Mill, Georgia, which is owned by Forest Products Division of Owens Illinois.

GEORGIA POWER COMPANY GENERAL PURCHASING AGREEMENT

TECHNOLOGY DEVELOPMENT CENTER TASK STATEMENT - BOA 95 - TASK A01 - E25-A04

PROJECT NAME: Establishing a Laboratory for Process Heating, Drying, and Curing

PRINCIPAL INVESTIGATOR: William Z. Black

PROGRESS REPORT FOR: August 1986

PROGRESS REPORT ON

ESTABLISHING A LABORATORY FOR PROCESS HEATING, DRYING AND CURING

Georgia Tech Project A04
January 1986 - August 1986

Progress on establishing a Laboratory for Process Heating, Drying and Curing has proceeded in a number of areas. First, space for the Laboratory has been obtained at the ATDC facility on the Georgia Tech campus. Second, a number of manufacturers of heating and drying equipment have been visited and arrangements have been initiated to either lease or purchase the equipment for installation in the Laboratory. Also, a number of Georgia industries that have potential heating and drying problems have been visited or have contacted Georgia Tech to explore our capabilities in solving their problems. A mathematical model has been formulated for the general process of drying in a porous media. It is anticipated that this model will be invaluable in helping to predict the important variables and media properties which will prove important in the dry of porous materials. Several drying projects have been identified that would be potential problems to attack once the Laboratory is equipped. Two of these projects are briefly described in the attachment to this report.

Finally a computer literature search of the pertinent scientific literature in the area of heating and drying has been completed. Over one hundred references have been cataloged on diskette and many of these references have been obtained from the Georgia Tech library.

I. Visits and Meetings with Manufacturers of Heating and Drying Equipment

1. Cober Electronics, Stamford, CT, 23 January 1986 -- Discussed line of industrial microwave heating equipment was well as experience with industrial applications.

2. Raytheon, Waltham, MA, 24 January 1986 -- Discussed line of industrial microwave equipment and their experience with drying of bulk fibers and carpet.

3. Radio Frequency Company, Mills, MA, 24 January 1986 -- Discussed line of industrial radio frequency equipment as well as experience with industrial applications.

4. Microdry Corporation, San Ramon California, 23 January 1986 - Discussed microwave dryers and their applicability to drying of carpets.

5. Greenbank Engineering, Blackburn, England, 17 March 1986 -- Set up and attended meeting on the Georgia Tech campus with representative from Greenbank Engineering regarding their A.R.F.A. (Air Radio Frequency Assisted) dryer and its application to industrial drying.

6. Strayfield/Lawson-Hemphill, Spartanburg, SC, 29 April 1986 -- Attended a meeting on the Georgia Tech campus with a representative from Strayfield, a British manufacturer of industrial radio frequency heating equipment, and a representative from Lawson-Hemphill, Strayfield's U.S. sales outlet, to discuss their line of equipment and its applications, particularly those related to the textile industry.

7. Several firms that manufacture traditional industrial infrared heating equipment have been contacted. They include: Fostoria Industries Inc., Glenro Inc., and Heraeus Americil.

II. Meetings with Georgia Industries and Planning for Heating and Drying Projects

1. Columbus Mills, Columbus, GA, December 1986 -- Discussed the application of electric-based heating for processing of carpet.
2. Briggs Plumbingware, Atlanta, GA, 17 February 1986 -- Discussed application of microwaves to slip casting of vitreous china sanitary ware.
3. Coats and Clark, Albany, GA, 16 July 1986 -- Evaluated condition of used Strayfield 20 kW RF dryer which was in storage at a Coats and Clark hand knitting yarn plant. Discussed application and problems associated with use of RF drying in the production of knitting yarns.
4. Standard Coosa Thatcher, Washington, GA, 18 April 1986 -- Contacted Mr. Don Durden concerning more efficient ways to dry up to 35,000 lbs. of bulk polyester/cotton yarn packages per day.
5. Kimberly Clark, Norcross GA, 28 February 1986 - Discussed a more practical manner in which to dry a composite fabric used for surgical gowns.
6. Johnson & Johnson Products, Inc. -- Discussed possibility of drying and curing prints on nonwoven fabrics by microwave or radio frequency energy.

III. Development of a General Drying Model

A general mathematical model is being developed so that the problem of simultaneous heat and mass transfer in a porous media in the presence of an E-M can be quantified. The model will be used to help guide the research work that will be undertaken once the microwave and radio frequency dryers are installed in the Laboratory.

A search of the literature pertaining to modeling heat and mass transfer in porous media and in textiles has been initiated, and a number of relevant references have been found. In addition, the literature dealing with microwave drying has been searched and a number of applicable references have been uncovered.

We believe that the traditional models used to describe the heat and moisture transfer in porous media such as soils and slurries that have been developed previously at Georgia Tech can be adapted for modeling the drying process that occurs in textile products such as carpets. Furthermore, the microwave drying process can be modeled by including in the energy equation a heat generation term that accounts for the energy absorbed by the water in the carpet from the microwave energy field. A preliminary model has been developed along these lines to identify the parameters that must be measured or otherwise obtained before the model can be used to predict the energy and moisture transfer. These parameters include the thermal properties (e.g. thermal conductivity and specific heat), the hydraulic properties (e.g. moisture retention and permeability), and the microwave energy absorption characteristics of the moist material. We expect to examine a simplified version of the model to ascertain how it can be applied to a hybrid cycle that combines the best features of conventional and microwave drying.

IV. Identification of Potential Research Projects

Two potential projects have been identified that will address the majority of drying problems faced by the Georgia textile industry and will utilize the type of drying equipment that will be used in the Process Heating, Drying and Curing Laboratory. These two projects are described on the following pages.

PROJECT 1

FEASIBILITY OF UTILIZING MICROWAVE ENERGY IN DRYING OF TUFTED NYLON CARPET

Purpose:

The objective of the study is to investigate the feasibility of using microwave energy in drying of tufted nylon carpets. The effects of drying method on aesthetics and economics will be studied. Conventional convective drying, microwave drying and combination of the two methods will be investigated.

Scope:

During 1986 a continuous line for drying carpet will be procurred and set-up. The line (shown schematically in Figure 1) should be capable of continuously processing carpet samples having a width of approximately twenty four inches. The system should be capable of drying carpet via conventional convective drying, microwave drying or some combination of the two methods. Once the line is set up, drying tests will be performed. Carpet drying involves several carpet and process parameters. Some of these are:

A. Dryer Parameters
- Convective Oven temperature
- Microwave Oven Energy Intensity
- Carpet Throughput Speed
- Carpet Moisture Regain Entering Dryer
- Carpet Moisture Regain Exiting Dryer
- Percent of Drying Achieved via Convection
- Percent of Drying Achieved via Microwaves

B. Carpet Parameters
- Style
- Weight

Only the parameters that will impact aesthetics and economics will be studied. Others will be held constant during the test. For example, carpet moisture regain entering the dryer will be held to approximately 40% which is typical of drying at Columbus Mills.

Equipment Needs:

The major equipment needed to conduct the project is shown schematically in Figure 1. The equipment needs include:

- Carpet Supply System
- Carpet Wet-Out Device
- Continuous Convection Dryer
- Carpet Collection Box
- Continuous Microwave Dryer
- Drive and Carpet Collection System.

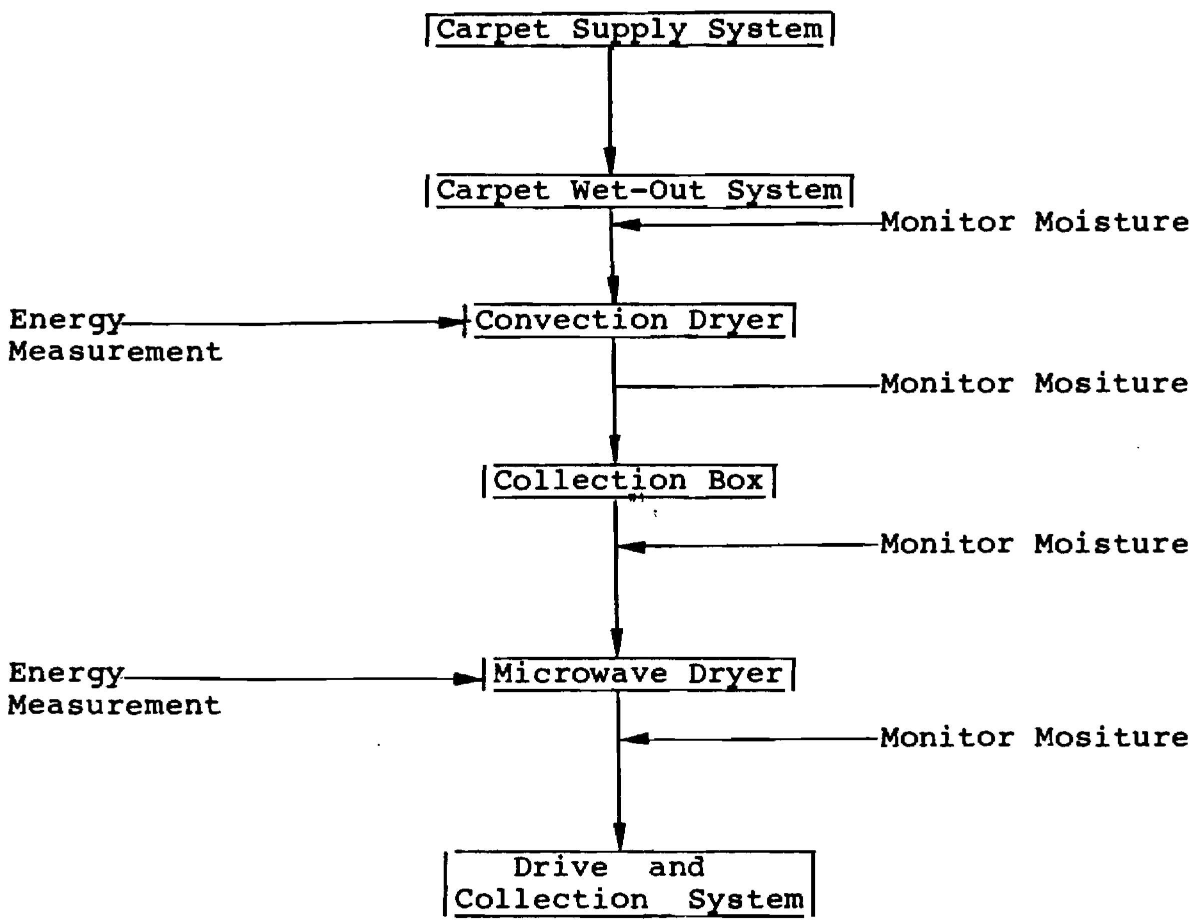

Figure 1. Schematic of Continuous Drying Line

Carpet Supply System

Carpet must be supplied uniformily to the continuous drying process. Hopefully, a fairly simple carpet let-off system can be either procured or fabricated. The carpet supply system should be a fairly low cost item.

Carpet Wet-Out Device

A device to wet out uniformity the carpet to a regain of approximately 40% is needed. Perhaps a spray system can be used to obtain the desired moisture level. The spray should consists of water plus chemicals normally found in the water in carpet dried commercially.

Continuous Convection Dryer

A major item needed for the project is a continuous convection dryer, including a variable-speed conveying system for carrying carpet through the oven. Also, the capability for monitoring energy input to the oven is desirable.

Carpet Collection Box

Since the percent drying achieved in the convection and microwave dryers are to be varied, it is doubtful the throughput speeds of the two ovens can be matched for some of the tests. Thus a carpet collection system between the dryers is probably necessary. The collection box can be fairly simple and probably fabricated at Georgia Tech.

Continuous Microwave Dryer

Another fairly expensive piece of equipment needed is a continuous microwave dryer, including a conveying system for transporting the carpet through the oven. The capability of varying the microwave field intensity is desirable. A watt meter for measuring energy input to the microwave unit is also needed.

Carpet Drive and Collection System

A carpet drive system for removing carpet as it leaves the microwave dryer is needed. A device for collecting the carpet as it is removed would be useful. The system can be fairly simple and could be fabricated at Georgia Tech.

Auxillary Equipment

Several pieces of equipment for making measurements on the continuous drying line are needed. Meters for reading the energy consumption of the dryers are needed. A moisture monitoring device that could be used to monitor continuously the carpet regain before and after the dryers would greatly reduce the quantity of work to be done manually.

Budget

The budgetory requirements ($29,Ø77) of W. W. Carr, T.E., are detailed in Figure 2. In addition to these requirements, personnel to aid in conducting the drying tests is needed. Also, funds for setting up the continuous drying line are needed.

Materials such as carpet will be needed for the drying tests; however, carpet companies such as Columbus Mills will be asked to donate materials for the tests.

PROJECT 2

Drying and Curing of Latex Adhesive Backing on Carpet

Tufted nylon carpet represents one of the major products produced in Georgia. Wet processing of carpet is energy-intensive (requiring approximately 12,000 BTU per pound of carpet). Drying and curing of latex adhesive backing on tufted carpet is one of the steps in wet processing. Typically, this step is conducted using convection ovens. The process is slow and energy-intensive, limiting rate and capacity. Utilization of microwave dryers instead of the conventional convection ovens has several potential advantages.

Rates for drying latex adhesive backing in convection ovens are relatively low. The adhesive is sandwiched between a primary backing (in which nylon yarn is tufted) and secondary backing. Thus, drying rates are limited by the rate at which heat is diffused into the adhesive through the surfaces. Dielectric-based (microwave and radio frequency) dryers have the advantage that they heat the material within and at places where water is present. For example, when a textile material containing water is exposed to a microwave field, the liquid water throughout the material is heated and may be converted to vapor while the textile material is not heated except through its contact with the heated water. Thus it is possible to rapidly heat and remove water without overheating the textile material which could cause thermal damage.

Microwave energy is more easily controlled than thermal energy, since.it can be turned on and off instantly. Thus, microwave heating does not have the thermal inertia of conventional heating processes. The level of energy can be quickly changed by adjusting field strength. Also, since the microwaves are coupled directly to the amount of water present, they can be used to measure uniformity and the heating energy required.

There are several potential benefits from the use of microwaves in drying and curing latex adhesive backing on carpet. Improvements in productivity and perhaps product quality are possible. The rapid application of energy that is possible with microwave should allow higher producting speeds and/on smaller equipment. With improved control and selective heating reduced energy consumption may be possible, particularly in plants making short runs.